

this requirement within one year of the effective date of this program.

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 1036 and 1037

[EPA–HQ–OAR–2019–0307; FRL–7423.1–01–OAR]

RIN 2060–AV21

Improvements for Heavy-Duty Engine and Vehicle Test Procedures

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: This final rule includes corrections, clarifications, additional flexibilities, and adjustment factors to improve the Greenhouse gas Emissions Model (GEM) compliance tool for heavy-duty vehicles while more closely matching the outputs produced by the original GEM version 3.0 that was used to establish the CO₂ standards for Model Years 2021 and later in the 2016 Heavy-duty Phase 2 final rule. Given the nature of this rule, there will be neither

significant environmental impacts nor significant economic impacts.

DATES: This final rule is effective on August 29, 2022. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of August 29, 2022.

ADDRESSES:

Docket: EPA has established a docket for this action under Docket ID No. EPA–HQ–OAR–2019–0307. Publicly available docket materials are available either electronically at www.regulations.gov or in hard copy at Air and Radiation Docket and Information Center, EPA Docket Center, EPA/DC, EPA WJC West Building, 1301 Constitution Ave. NW, Room 3334, Washington, DC. Certain material, such as copyrighted material, is not placed on the internet and will be publicly available only at the EPA Docket Center. For further information on EPA Docket Center services and the current status, please visit us online at www.epa.gov/dockets.

Public participation: *Docket:* All documents in the docket are listed on the www.regulations.gov website. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute.

Certain other material, such as copyrighted material, is not placed on the internet and will be publicly available only in hard copy form through the EPA Docket Center at the location listed in the **ADDRESSES** section of this document.

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I. General Information

Does this action apply to me?

This action relates to companies that manufacture or sell new heavy-duty engines and vehicles as defined under EPA's CAA regulations.¹ Regulated categories and entities include the following:

NAICS codes ^a	NAICS titles
333618, 336111, 336112, 336120, 336211, 336999.	Other Engine Equipment Manufacturing, Automobile Manufacturing, Light Truck and Utility Vehicle Manufacturing, Heavy Duty Truck Manufacturing, Motor Vehicle Body Manufacturing, All Other Transportation Equipment Manufacturing.

^a North American Industry Classification System (NAICS).

This list is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. If you have questions regarding the applicability of this action to a particular entity, consult the person listed in the **FOR FURTHER INFORMATION CONTACT** section.

What action is the Agency taking?

This action amends the procedures for demonstrating compliance with the CO₂ emission standards for heavy-duty highway engines and vehicles with several corrections, clarifications, and additional flexibilities.

EPA published a proposed rule on May 12, 2020 (85 FR 28153) (“Technical Amendments proposed rule”). EPA issued a corresponding final rulemaking (“Technical Amendments final rule”) relating to most revisions in the Technical Amendments proposed rule

(86 FR 34308, June 29, 2021). Additionally, for the amendments in this final action, EPA published a supplemental notice of proposed rulemaking (“Technical Amendments supplemental proposed rule”) with additional amendments for certain aspects of the modeling parameters used for certifying vehicles (86 FR 34189, June 29, 2021).

What are the incremental costs and benefits of this action?

This action is limited in scope and does not have significant economic or environmental impacts. EPA has therefore not estimated the potential costs or benefits of this final rule.

II. Greenhouse Gas Emissions Model (GEM) Background

The Greenhouse gas Emissions Model (GEM) is a computer application that

estimates the greenhouse gas (GHG) emissions and fuel efficiency performance of specific aspects of heavy-duty vehicles. GEM uses several vehicle-specific inputs, such as engine fuel maps, aerodynamic drag coefficients, and vehicle weight ratings, to simulate vehicle and engine operation and model the amount of CO₂ emitted over multiple duty cycles for tractors and vocational vehicles. The resulting CO₂ values over these cycles are weighted by GEM to provide a Default FEL CO₂ Emissions value. GEM version 3.0 was used to set standards in the Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles Phase 2 (“Phase 2”) rulemaking (81 FR 73478). For purposes of determining compliance, Default FEL CO₂ Emissions

¹ “Heavy-duty engine” and “heavy-duty vehicle” are defined in 40 CFR 1037.801.

from GEM are compared to the applicable Phase 2 vehicle standard.

In the Technical Amendments proposed rule, we proposed several amendments to GEM 3.0, including corrections, clarifications, and additional flexibilities in a revised version of the model, GEM 3.5 (85 FR 28145). EPA also requested comment on whether any differences in GEM output values resulting from changes to the model would impact the effective stringency of the program and, if so, whether EPA should revise the GEM model itself or address such impacts via regulations (see 85 FR 28145). Comments received in response to the Technical Amendments proposed rule supported most of the proposed updates to GEM and requested additional revisions to further improve the model.² The California Air Resources Board (CARB) provided comment stating the importance of GEM results being consistent with the 2016 Phase 2 final rule program standards to avoid affecting program stringency. CARB recommended that EPA revise GEM in order to ensure stringency is maintained.³

After considering the comments received, EPA applied further changes to GEM 3.5 and released in October of 2020 a new development version of GEM, GEM 3.7, to the public for download and review by stakeholders to evaluate and assess the performance of this revised model. GEM 3.7 incorporated some corrections and improvements relative to the proposed version GEM 3.5, as noted in the corresponding memorandum in the rulemaking docket (October 23, 2020 memorandum).⁴

While evaluating GEM 3.7, we found differences in the output values for some tractor and vocational vehicles compared to the output values from GEM 3.0 (the version used to set the Phase 2 CO₂ standards). To understand

the differences between GEM 3.0 and GEM 3.7, we replicated the process used in 2016 to determine the numerical level of the Phase 2 standards. Without an adjustment to the resulting GEM output value, these differences in GEM output values when compared to the Phase 2 final rule could be considered an effective change in stringency. In light of GEM 3.7 output differences and considering CARB's comment, we identified adjustment factors in the October 23, 2020 docket memorandum that could be applied to the unrounded GEM 3.7 output values to better ensure effective stringency of the standards is maintained.⁵ The Truck and Engine Manufacturers Association (EMA) requested additional time for its members to review the potential updates to the model in GEM 3.7 and evaluate the impact of the adjustment factors made available.⁶

In the Technical Amendments final rule, EPA finalized a revised version of GEM (GEM 3.5.1) that included the changes proposed in GEM version 3.5 as well as changes that corrected three errors in the GEM 3.5 code and did not include any adjustment factors. GEM 3.5.1 included the following updates to GEM 3.5:

- Corrected duty cycle weighting factors for vocational vehicles in the Heavy Heavy-Duty Multipurpose subcategory.
- Corrected an idle map error when the cycle average engine fuel mapping procedure is used for all three drive cycles.
- Corrected a functional error that unnecessarily required manufacturers to include transmission power loss data when using the option to enter a unique (instead of default) k-factor for the torque converter.

In the Technical Amendments supplemental proposed rule, EPA proposed to revise GEM through additional changes in an updated

version of GEM (GEM 3.8 which was identical to GEM 3.7, except that GEM 3.8 included changes to the GEM HIL model). This rule also proposed to revise GEM's test procedures to include adjustment factors and to improve the GEM compliance tool for heavy-duty vehicles while more closely matching the outputs produced by the original GEM version 3.0 that was used to establish the CO₂ standards for Model Years 2021 and later in the 2016 Heavy-duty Phase 2 final rule. The Technical Amendments supplemental proposed rule also proposed that GEM 3.5.1 would be limited to use for model year ("MY") 2021 only, except where MY 2021 data could be used for carryover requests for certificates of conformity for MY 2022 and future years for qualifying vehicles under § 1036.235(d) (but in such circumstances EPA proposed that manufacturers would still be required to use GEM 3.8 for end-of-year reporting for MY 2022 and future years).⁷

After considering the comments received in response to our Technical Amendments supplemental proposed rule, EPA applied further potential changes to GEM 3.8 and released a new development version of GEM, GEM 3.9, in December 2021. EPA also updated the adjustment factors released with the GEM 3.8 version to accommodate the changes made in the development of GEM 3.9. GEM 3.9 also included an updated method of creating these adjustment factors using unrounded GEM results instead of using the rounded GEM results as was done with GEM 3.8. GEM 3.9 was released to the public for download and review by stakeholders to evaluate and assess the performance of this revised model. GEM 3.9 incorporated corrections and improvements relative to GEM 3.8, as noted in the corresponding memorandum in the rulemaking docket.⁸ Table 1 summarizes the history of the different versions of GEM.

TABLE 1—HISTORY OF GEM RELEASES

Version	History
GEM 3.0	Original official version finalized in the 2016 Phase 2 final rule.
GEM 3.5	Unofficial version proposed in the Technical Amendments proposed rule.
GEM 3.5.1	Version finalized in the Technical Amendments final rule.

² See "Improvements for Heavy-Duty Engine and Vehicle Test Procedures, and other Technical Amendments Response to Comments", Publication Number: EPA-420-R-20-026, December 2020. Chapter 2 of the Response to Comments provides additional details on the amendments, clarifications requested by commenters, and our responses to most of the comments to the NPRM.

³ California Air Resources Board, Docket number EPA-HQ-OAR-2019-0207-0030.

⁴ Nelson, Brian. Memorandum to Docket EPA-HQ-OAR-2019-0307. "Development version of GEM and adjustment factors". October 23, 2020. Docket number EPA-HQ-OAR-2019-0307-0083. Also available online: <https://www3.epa.gov/otaq/gem-p2v3.7-release-memo-2020-10-23.pdf>.

⁵ *Id.*
⁶ Charmley, Bill. Memorandum to Docket EPA-HQ-OAR-2019-0307. "EPA discussions with the Truck and Engine Manufacturers Association, and with the California Air Resources Board, regarding

Highway Heavy-Duty Technical Amendments." December 14, 2020. Docket Number EPA-HQ-OAR-2019-0307-0092.

⁷ See 86 FR 34192.
⁸ Nelson, Brian. Memorandum to Docket EPA-HQ-OAR-2019-0307. "Development version of GEM3.9 and adjustment factors". December 20, 2021. Docket Number EPA-HQ-OAR-2019-0307-0092. Available online: <https://www.epa.gov/system/files/documents/2021-12/gem-v3.9-adjust-factors-memo-2021-12-20-.pdf>.

TABLE 1—HISTORY OF GEM RELEASES—Continued

Version	History
GEM 3.7	Unofficial version released between the Technical Amendments proposed and final rules.
GEM 3.8	Unofficial version proposed in the Technical Amendments supplemental proposed rule.
GEM 3.8 HIL	Version finalized in the Technical Amendments final rule for powertrain testing defined in 40 CFR 1037.550.
GEM 3.9	Unofficial version released after the Technical Amendments supplemental proposed rule.

III. GEM 4.0

A. Updates to GEM

This final rule further revises GEM and includes GEM adjustment factors within the model. Applying the adjustment factors within GEM will help reduce potential process errors.

We are adopting GEM version 4.0.^{9 10} This updated version of the model allows additional compliance flexibilities and improves the vehicle simulation by incorporating the following improvements relative to GEM 3.5.1:

1. Changed limits on engine input to allow small negative torque inputs.
2. Corrected how GEM adjusts the idle fueling of the transient cycle by using the same idle duration time both for subtracting the idle fuel rate from the transient cycle average engine fuel map and for adding back in the simulated idle fuel rate.
3. Added an option for vocational vehicles to input a value for neutral coasting in GEM and amend the related test procedure in 40 CFR 1037.520(j)(1).
4. Corrected manual and automated manual transmissions to perform clutched upshifts for Heavy Heavy-Duty Vehicles (HDV).
5. Allow input files from previous versions of GEM.
6. Changed GEM to not merge drive idle fuel map with default steady-state fuel map.
7. Corrected errors with the default fuel maps that are used for Custom Chassis vehicles.

8. Changed the regression model that is used for interpolating the cycle average fuel maps for the cruise cycles to improve the accuracy and representativeness of the regression model.¹¹

9. Changed GEM to account for the emissions performance of stop-start automatic and engine shutdown systems (AESS) technologies when the powertrain test procedure is used to create the fuel map input file.

10. Applies mass of CO₂ to gallons of fuel conversion factor by combustion type instead of fuel type.

11. Includes a change to the carbon mass fraction for E85 to the value in Table 1 of 40 CFR 1036.530.

12. Includes a 5% tolerance for declared idle target speed vs idle fuel map test points.

13. Changed how GEM models powertrain accessory work for 55/65 mph cruise cycles and idle cycles.¹²

a. *55/65 mph cruise cycles*: GEM uses the slope from the fuel-versus-work regression of the cruise cycle average fuel map to account for emissions from accessory work

b. *Idle cycles*: GEM uses the slope from the fuel-versus-work regression of the transient cycle average fuel map to account for emissions from accessory work

14. Changed GEM output label “FEL CO₂ Emissions” to “Default FEL CO₂ Emissions” and “FEL Consumption” to “Default FEL Consumption”.

15. Changed units of GEM tire rolling resistance input from “kg/t” to “N/kN”.

16. Updated GEM hardware in the loop (HIL) to better reflect operation during transmission shifting.

To ensure that these changes we are finalizing into GEM 4.0 do not change the effective stringency of the Phase 2 CO₂ standards, we are adopting adjustment factors in GEM 4.0. In GEM 4.0, EPA has updated the adjustment factors released with the GEM 3.8 version to accommodate the changes made in the development of GEM 4.0 and the updated method of creating these factors using unrounded GEM results (versus using the rounded GEM results as was done with GEM 3.8). The revised adjustment factors are included below and are a function of regulatory subcategory and the vehicle model year (*i.e.*, MY 2021–2023; MY 2024–2026; and MY 2027 and later).¹³ One exception is tractors with automatic transmission. For tractors with automatic transmissions, GEM 4.0 includes an adjustment factor of zero.¹⁴ In GEM 4.0, the adjustment factors in Table 2 are applied to the composite GEM result within the program itself using the following equation.

$$e_{CO2\text{Corrected}} = \frac{e_{CO2}}{1 + AF}$$

Where:

e_{CO2} = unrounded composite CO₂ emissions from GEM.

AF = the applicable adjustment factor from Table 1.

TABLE 2—GEM 4.0 ADJUSTMENT FACTORS

Regulatory subcategory	Adjustment factor		
	MY 2021–2023 vehicle	MY 2024–2026 vehicle	MY 2027-and-later vehicle
Class 7 Day Cab Low Roof	–0.0107	–0.0094	–0.0097
Class 7 Day Cab Mid Roof	–0.0105	–0.0091	–0.0091
Class 7 Day Cab High Roof	–0.0090	–0.0094	–0.0093
Class 8 Day Cab Low Roof	–0.0062	–0.0074	–0.0069
Class 8 Sleeper Cab Low Roof	–0.0010	–0.0013	–0.0010

⁹ Greenhouse gas Emissions Model (GEM) Phase 2, Version 4.0, January 2022. A working version of this software is also available for download at <https://www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-emissions-model-gem-medium-and-heavy-duty>.

¹⁰ The changes summarized in the following listed items 13, 14, 15, and 16 are changes that were

made to GEM version 4.0 relative to GEM version 3.9.

¹¹ Sanchez, James. Memorandum to Docket: EPA–HQ–OAR–2019–0307. GEM Regression Model for Cycle-Average Cruise Cycles. March 11, 2022.

¹² Sanchez, James. Memorandum to Docket: EPA–HQ–OAR–2019–0307. Modeling of Powertrain Accessory Work in GEM. March 11, 2022.

¹³ Table 2 summarizes the adjustment factors included in GEM 4.0. Section III of the preamble discusses for which model years GEM 4.0 applies.

¹⁴ Chapter 1.6 of the Response to Comments provides additional details on why GEM 4.0 includes an adjustment factor of zero for tractors with automatic transmissions.

TABLE 2—GEM 4.0 ADJUSTMENT FACTORS—Continued

Regulatory subcategory	Adjustment factor		
	MY 2021–2023 vehicle	MY 2024–2026 vehicle	MY 2027-and-later vehicle
Class 8 Day Cab Mid Roof	–0.0064	–0.0070	–0.0065
Class 8 Sleeper Cab Mid Roof	–0.0010	–0.0011	–0.0010
Class 8 Day Cab High Roof	–0.0061	–0.0071	–0.0067
Class 8 Sleeper Cab High Roof	–0.0011	–0.0010	–0.0009
Class 8 Heavy Haul	–0.0068	–0.0067	–0.0070
Multi-Purpose Light HDV Compression-ignition		–0.0006	
Regional Light HDV Compression-ignition		0.0005	
Urban Light HDV Compression-ignition		0.0000	
Multi-Purpose Medium HDV Compression-ignition		–0.0030	
Regional Medium HDV Compression-ignition		0.0008	
Urban Medium HDV Compression-ignition		–0.0036	
Multi-Purpose Heavy HDV Compression-ignition		0.0097	
Regional Heavy HDV Compression-ignition		0.0006	
Urban Heavy HDV Compression-ignition		0.0132	
Multi-Purpose Light HDV Spark-ignition		0.0001	
Regional Light HDV Spark-ignition		0.0008	
Urban Light HDV Spark-ignition		0.0011	
Multi-Purpose Medium HDV Spark-ignition		0.0015	
Regional Medium HDV Spark-ignition		0.0005	
Urban Medium HDV Spark-ignition		0.0028	
School bus	–0.0031		–0.0030
Motor home	0.0001		0.0001
Coach bus	0.0018		0.0019
Other bus	0.0132		0.0135
Refuse hauler	0.0124		0.0126
Concrete mixer	0.0124		0.0125
Mixed-use vehicle	0.0124		0.0125
Emergency vehicle	0.0122		0.0124

B. Allowable Versions of GEM for Certification and Compliance

We are incorporating by reference into the regulations the revised version of the model, GEM 4.0. GEM 4.0 is adopted upon the effective date of this final rule to demonstrate compliance with the Phase 2 standards under 40 CFR 1037.520, including end-of-year reporting. Due to the timing of this final rule, we are applying the requirement to use GEM version 4.0 starting with MY 2024. EPA is also finalizing provisions to allow for an orderly transition to the updated GEM version. For MY 2022 through 2023, manufacturers may also use GEM 3.0 or GEM 3.5.1 under interim provision § 1037.150(bb) to demonstrate compliance with the Phase 2 standards. Manufacturers may use different versions of GEM for different families within each model year before MY 2024. Manufacturers may also change versions of GEM for MY 2022 and 2023 vehicle families between the initial application for certification and submission of the final report after the end of the model year; however, manufacturers would need to document any changes in the GEM version for MY 2022 and 2023 vehicle families by submitting a running change as an

amendment to the application for certification under § 1036.225. We also note that, once a manufacturer amends an application for certification to rely on GEM 4.0 or submits a new application that relies on GEM 4.0 under interim provision § 1037.150(bb), the manufacturer may not revert back to an earlier version of GEM for that vehicle family.

Changing to a different version of GEM for MY 2021 is a special case. Manufacturers have certified all their MY 2021 families using either GEM 3.0 or GEM 3.5.1. However, the model year has already ended. The flexibility to use a different official version of GEM, including GEM 4.0, therefore applies only for the end-of-year report that is due in September 2022. We are also adopting this flexibility only for vehicle families certified to the standards for custom chassis in § 1037.105(h). We are providing this flexibility for vehicle families meeting standards for custom chassis because we determined that there was an unintended increase in effective stringency for those vehicles in GEM 3.5.1. Manufacturers don't need the flexibility to change GEM versions for other families because they did not have this unexpected impact in GEM 3.5.1 and they have already closed out

their model year. Finally, manufacturers must document any change in the version of GEM for end-of-year reporting in the submission of those end-of-year reports.

The requirement to start using GEM 4.0 also applies starting with MY 2024 for manufacturers generating fuel maps using either engine testing or powertrain testing. Powertrain fuel mapping procedures are including in the Hardware-in-Loop (HIL) model that is part of GEM. Under interim provision 40 CFR 1036.150(r), manufacturers may certify in MY 2021 through 2023 with fuel maps generated using GEM 3.0, GEM 3.5.1, GEM HIL 3.8, or GEM 4.0. Manufacturers may continue to certify in MY 2024 and later using fuel maps generated using earlier GEM versions in cases where the manufacturer qualifies for carryover certification. If we conduct or direct the manufacturer to do confirmatory testing, selective enforcement audits, or in-use testing of a set of engine or powertrain fuel maps, we will use or direct the manufacturer to use the same version of GEM that the manufacturer used to create those fuel maps. We intend to review the manufacturer's use of this carryover allowance going forward; we may consider in a future rulemaking whether

there is a continued need for manufacturers to use fuel maps generated using these transitional versions of GEM.

IV. Updates to Test Procedures

We are finalizing revisions to the regulatory text in 40 CFR parts 1036 and 1037 to clarify or make changes to the test procedures used to create inputs for GEM.

We are finalizing changes to 40 CFR 1036.503(b)(4) to address the handling and use of automatic stop-start systems and automatic engine shutdown systems when performing powertrain fuel map testing under 40 CFR 1037.550. Finalization of the Phase 2 technical amendments left it unclear with respect to how these systems and accessory loads were handled by GEM for powertrain testing. The revisions require that any engine stop-start and automatic shutdown systems be disabled prior to performing powertrain testing, as the effects of these systems will be handled by GEM, when GEM is used to determine the emissions of the vehicle. We are also clarifying the accessory load that should be used by primary intended service class during the powertrain test for hybrid engines so that hybrid engines are tested with the same accessory loads that are used for conventional engines. The power representing the accessory load added for Light HDV, Medium HDV, and Heavy HDV is 1.5, 2.5, and 3.5 kW, respectively.

In GEM 3.5.1, finalized in the Technical Amendments final rule, we included updates to handle point deletion in GEM but did not update our regulation, which required the prior approach of manual removal of such points. Consistent with this prior change to having GEM handle point deletion (now in GEM 4.0), we are now removing that requirement in 40 CFR 1036.535(d)(3), for steady-state fuel maps used for cycle-average fuel mapping of the highway cruise cycles, that requires manual removal of the points from the default map that are below 115% of the maximum speed and 115% of the maximum torque of the boundaries of the points measured in 40 CFR 1036.535(d)(1). See Section 1.7 of the Response to Comments document for further discussion.

We are finalizing changes to GEM inputs determined in 40 CFR 1036.540(e) for cycle-average fuel maps for the cruise cycles. This revision changes the cruise cycle fuel map outputs from N/V (powertrain rotational speed divided by vehicle speed in revolutions per meter as defined specifically in 40 CFR part 1036), fuel

mass consumption, and work to average engine speed, average engine torque, fuel mass consumption, and work. We are also adding a new vehicle configuration output matrix for cruise cycles to denote the differences that now exist for the testing outputs needed for GEM for transient and cruise cycles. These changes align the test procedure with changes to the regression model in GEM that is used for interpolating the cycle average fuel maps for the cruise cycles. The change in the regression model aligns the GEM results when the cycle-average method is used for the cruise cycles with the GEM results when the standard engine fuel mapping procedure is used (40 CFR 1036.503(b)(1)).

We are finalizing changes in 40 CFR 1037.510 to correct the example problem that solves for $e_{CO2comp}$. The value for \bar{v}_{moving} was correctly listed as 38.41 mi/hr in the example; however, the value entered into the example problem of 41.93 mi/hr was in error. The change updates the example problem to the correct value.

We are finalizing changes in 40 CFR 1037.520(j)(1) to allow the input value of 1.5 in GEM of vocational vehicles that include intelligent controls (predictive cruise control). This change recognizes the CO₂ benefit of this technology in GEM for vocational vehicles, which was previously only allowed for tractors.

We are finalizing an amendment in 40 CFR 1037.550(a)(8) to clarify that accessory loads should not be included in powertrain testing when conducting a powertrain test to generate inputs to GEM if torque is measured at the axle input shaft or wheel hubs. We are also finalizing changes to 40 CFR 1037.550(f) to clarify for hybrid engines that GEM must be configured with the applicable accessory load as specified in 40 CFR 1036.503. We are also finalizing a change at 40 CFR 1037.550(o)(4) to note that the regulatory section is now applicable only to the transient cycle specified in appendix A of 40 CFR part 1037. We are also finalizing a new 40 CFR 1037.550(o)(6) to require calculating the average powertrain output speed and the average powertrain output torque for the cruise cycles. The changes to the calculations in 40 CFR 1037.550(o)(6) are necessary to address the changes in GEM inputs required for cycle-average fuel maps for cruise cycles. We are also adding a new vehicle configuration output matrix for cruise cycles to denote the differences that now exist for the testing outputs needed for GEM for transient and cruise cycles. As discussed in Section III of the preamble, we are changing the regression model used for interpolating

the cycle-average fuel maps for the cruise cycles to improve the accuracy and representativeness of the regression model.

V. Statutory Authority and Executive Order Reviews

Additional information about these statutes and Executive Orders can be found at www.epa.gov/laws-regulations/laws-and-executive-orders.

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This action is a significant regulatory action that was submitted to the Office of Management and Budget (OMB) for review. Any changes made in response to OMB recommendations have been documented in the docket.

B. Paperwork Reduction Act (PRA)

This action does not impose any new information collection burden under the PRA. OMB has previously approved the information collection activities contained in the existing regulations and has assigned OMB control numbers 2060–0287. This rule clarifies procedures without affecting information collection requirements.

C. Regulatory Flexibility Act (RFA)

I certify that this action will not have a significant economic impact on a substantial number of small entities under the RFA. In making this determination, the impact of concern is any significant adverse economic impact on small entities and that the agency is certifying that this rule will not have a significant economic impact on a substantial number of small entities if the rule has no net burden on the small entities subject to the rule. This action is designed to make various corrections and adjustments to compliance provisions; as a result, we anticipate no costs associated with this rule. We have therefore concluded that this action will have no net regulatory burden for all directly regulated small entities.

D. Unfunded Mandates Reform Act (UMRA)

This action does not contain any unfunded mandate as described in UMRA, 2 U.S.C. 1531–1538, and does not significantly or uniquely affect small governments. This action imposes no enforceable duty on any Tribal, state, or local governments. Requirements for the private sector do not exceed \$100 million in any one year.

E. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have Tribal implications as specified in Executive Order 13175. This rule will be implemented at the Federal level and affects engine and vehicle manufacturers. Thus, Executive Order 13175 does not apply to this action.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

This action is not subject to Executive Order 13045 because it is not economically significant as defined in Executive Order 12866, and because the EPA does not believe the environmental health or safety risks addressed by this action present a disproportionate risk to children. There are no environmental health or safety risks created by this action that could present a disproportionate risk to children.

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use

This action is not a “significant energy action” because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. Further, we have concluded that this action is not likely to have any adverse energy effects because the regulatory changes are limited to certification procedures for meeting the Phase 2 GHG standards.

I. National Technology Transfer and Advancement Act (NTTAA) and 1 CFR Part 51

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (“NTTAA”), Public Law 104–113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (*e.g.*, materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs agencies to

provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards. This action involves technical standards.

With one exception, the standards included in the regulatory text as incorporated by reference in 40 CFR part 1037 were all previously approved for incorporation by reference (IBR) and no change is included in this action. In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference new versions of the GEM. EPA is publishing new versions of the GEM, which we use for certifying heavy-duty highway vehicles to the Phase 2 greenhouse gas emission standards in 40 CFR part 1037. We are also restoring a version of GEM that we withdrew in a different rulemaking. The model calculates GHG emission rates for heavy-duty highway vehicles based on input values defined by the manufacturer. GEM Version 4.0 applies broadly for Phase 2 vehicles. GEM Version 3.0 and GEM Version 3.5.1 apply optionally for model years 2021 through 2023 to facilitate compliance during a transition period. The different versions of GEM are referenced in § 1037.520. The model is available from EPA as noted in the amended regulations at 40 CFR 1037.810.¹⁵

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

The EPA believes this action does not have disproportionately high and adverse human health or environmental effects on minority populations, low-income populations or indigenous peoples, as specified in Executive Order 12898 (59 FR 7629, February 16, 1994). Due to the small environmental impact, this regulatory action will not have a disproportionate adverse effect on minority populations, low-income populations, or indigenous peoples.

K. Congressional Review Act (CRA)

This action is subject to the CRA, and EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is not a “major rule” as defined by 5 U.S.C. 804(2).

L. Judicial Review

Under CAA section 307(b)(1), judicial review of this final rule is available only by filing a petition for review in the U.S. Court of Appeals for the District of

Columbia Circuit by September 26, 2022. Under CAA section 307(d)(7)(B), only an objection to this final rule that was raised with reasonable specificity during the period for public comment can be raised during judicial review. CAA section 307(d)(7)(B) also provides a mechanism for EPA to convene a proceeding for reconsideration, “[i]f the person raising an objection can demonstrate to EPA that it was impracticable to raise such objection within [the period for public comment] or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of the rule.” Any person seeking to make such a demonstration should submit a Petition for Reconsideration to the Office of the Administrator, Environmental Protection Agency, Room 3000, William Jefferson Clinton Building, 1200 Pennsylvania Ave. NW, Washington, DC 20460, with an electronic copy to the person listed in **FOR FURTHER INFORMATION CONTACT**, and the Associate General Counsel for the Air and Radiation Law Office, Office of General Counsel (Mail Code 2344A), Environmental Protection Agency, 1200 Pennsylvania Ave. NW, Washington, DC 20004. Note that under CAA section 307(b)(2), the requirements established by this final rule may not be challenged separately in any civil or criminal proceedings brought by EPA to enforce these requirements.

List of Subjects*40 CFR Part 1036*

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Greenhouse gases, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1037

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

Michael S. Regan,
Administrator.

For the reasons set out in the preamble, we are amending title 40, chapter I of the Code of Federal Regulations as set forth below.

¹⁵ GEM is most easily available at www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-emissions-model-gem-medium-and-heavy-duty.

[illegible]

(ii) For the cruise cycles:

TABLE 7 TO PARAGRAPH (e)(7)(ii) OF § 1036.540—GENERIC EXAMPLE OF AN OUTPUT MATRIX FOR CRUISE CYCLE VEHICLE CONFIGURATIONS

Parameter	Configuration								
	1	2	3	4	5	6	7	8	9
$m_{fuel[cycle]}$ $\bar{t}_{engine[cycle]}$ $T_{engine[cycle]}$ $W_{[cycle]}$									

PART 1037—CONTROL OF EMISSIONS FROM NEW HEAVY-DUTY MOTOR VEHICLES

■ 6. The authority citation for part 1037 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 7. Amend § 1037.150 by adding paragraph (bb) to read as follows:

§ 1037.150 Interim provisions.
* * * * *

(bb) *Transition to updated GEM.* (1) Vehicle manufacturers may demonstrate compliance with Phase 2 GHG standards in model years 2021 through 2023 using GEM Phase 2, Version 3.0, Version 3.5.1, or Version 4.0 (incorporated by reference in § 1037.810). Manufacturers may change to a different version of GEM for model years 2022 and 2023 for a given vehicle

family after initially submitting an application for certification; such a change must be documented as an amendment under § 1037.225. Manufacturers may submit an end-of-year report for model year 2021 using any of the three regulatory versions of GEM, but only for demonstrating compliance with the custom-chassis standards in § 1037.105(h); such a change must be documented in the report submitted under § 1037.730. Once a manufacturer certifies a vehicle family based on GEM Version 4.0, it may not revert back to using GEM Phase 2, Version 3.0 or Version 3.5.1 for that vehicle family in any model year.

(2) Vehicle manufacturers may certify for model years 2021 through 2023 based on fuel maps from engines or powertrains that were created using GEM Phase 2, Version 3.0, Version

3.5.1, or Version 4.0 (incorporated by reference in § 1037.810). Vehicle manufacturers may alternatively certify in those years based on fuel maps from powertrains that were created using GEM Phase 2, Version 3.0, GEM HIL model 3.8, or GEM Phase 2, Version 4.0 (incorporated by reference in § 1037.810). Vehicle manufacturers may continue to certify vehicles in later model years using fuel maps generated with earlier versions of GEM for model year 2024 and later vehicle families that qualify for using carryover provisions in § 1037.235(d).

■ 8. Amend § 1037.510 by revising paragraph (b) to read as follows:

§ 1037.510 Duty-cycle exhaust testing.
* * * * *

(b) Calculate the official emission result from the following equation:

$$e_{CO2comp} = \frac{1}{PL \cdot \bar{v}_{moving} \cdot (1 - w_{drive-idle} - w_{parked-idle})} \cdot \left((1 - w_{drive-idle} - w_{parked-idle}) \cdot \left(\frac{w_{transient} \cdot m_{transient}}{D_{transient}} + \frac{w_{55} \cdot m_{55}}{D_{55}} + \frac{w_{65} \cdot m_{65}}{D_{65}} \right) \cdot \bar{v}_{moving} \right) + w_{drive-idle} \cdot \bar{m}_{drive-idle} + w_{parked-idle} \cdot \bar{m}_{parked-idle}$$

Eq. 1037.510-1

Where:

$e_{CO2comp}$ = total composite mass of CO₂ emissions in g/ton-mile, rounded to the nearest whole number for vocational vehicles and to the first decimal place for tractors.

PL = the standard payload, in tons, as specified in § 1037.705.

\bar{v}_{moving} = mean composite weighted driven vehicle speed, excluding idle operation, as shown in table 1 to this section for Phase 2 vocational vehicles. For other vehicles, let $\bar{v}_{moving} = 1$.

$w_{[cycle]}$ = weighting factor for the appropriate test cycle, as shown in table 1 to this section.

$m_{[cycle]}$ = CO₂ mass emissions over each test cycle (other than idle).

$D_{[cycle]}$ = the total driving distance for the indicated duty cycle. Use 2.842 miles for the transient cycle, and use 13.429 miles for both of the highway cruise cycles.

$\bar{m}_{[cycle]-idle}$ = CO₂ emission rate at idle.

Example:

Class 7 vocational vehicle meeting the Phase 2 standards based on the Regional duty cycle.

$PL = 5.6$ tons
 $\bar{v}_{moving} = 38.41$ mi/hr
 $w_{transient} = 20\% = 0.20$
 $w_{drive-idle} = 0\% = 0$
 $w_{parked-idle} = 25\% = 0.25$
 $w_{55} = 24\% = 0.24$
 $w_{65} = 56\% = 0.56$
 $m_{transient} = 4083$ g
 $m_{55} = 13834$ g
 $m_{65} = 17018$ g
 $D_{transient} = 2.8449$ miles
 $D_{55} = 13.429$ miles
 $D_{65} = 13.429$ miles
 $\bar{m}_{drive-idle} = 4188$ g/hr
 $\bar{m}_{parked-idle} = 3709$ g/hr

$$e_{\text{CO}_2} = \frac{1}{5.6 \cdot 38.41 \cdot (1 - 0 - 0.25)} \cdot \left((1 - 0.0 - 0.25) \cdot \left(\frac{0.20 \cdot 4083}{2.8449} + \frac{0.24 \cdot 13834}{13.429} + \frac{0.56 \cdot 17018}{13.429} \right) \right) \\ e_{\text{CO}_2} = 228 \text{ g/ton-mile}$$

* * * * *

■ 9. Amend § 1037.520 by revising the introductory text and paragraph (j)(1) to read as follows:

§ 1037.520 Modeling CO₂ emissions to show compliance for vocational vehicles and tractors.

This section describes how to use the Greenhouse gas Emissions Model (GEM) (incorporated by reference in § 1037.810) to show compliance with the CO₂ standards of §§ 1037.105 and 1037.106 for vocational vehicles and tractors. Use GEM version 2.0.1 to demonstrate compliance with Phase 1 standards; use GEM Phase 2, Version 4.0 to demonstrate compliance with Phase 2 standards. Use good engineering judgment when demonstrating compliance using GEM. See § 1037.515 for calculation procedures for demonstrating compliance with trailer standards.

* * * * *

(j) * * *

(1) *Intelligent controls.* Enter 2 for tractors with predictive cruise control. This includes any cruise control system that incorporates satellite-based global-positioning data for controlling operator demand. For tractors without predictive cruise control and for all vocational vehicles, enter 1.5 if they have neutral coasting, unless good engineering judgment indicates that a lower percentage should apply.

* * * * *

■ 10. Amend § 1037.550 by:

■ a. Revising paragraph (a)(3) introductory text.

■ b. Adding and reserving paragraph (a)(7).

■ c. Adding paragraph (a)(8).

■ d. Revising paragraphs (f) introductory text and (o).

The additions and revisions read as follows:

§ 1037.550 Powertrain testing.

* * * * *

(a) * * *

(3) Powertrain testing depends on models to calculate certain parameters. You can use the detailed equations in this section to create your own models, or use the GEM HIL model contained within GEM Phase 2, Version 4.0 (incorporated by reference in § 1037.810) to simulate vehicle hardware elements as follows:

* * * * *

(7) [Reserved]

(8) Do not apply accessory loads when conducting a powertrain test to generate inputs to GEM if torque is measured at the axle input shaft or wheel hubs.

* * * * *

(f) *Driveline and vehicle model.* Use the GEM HIL model's driveline and vehicle submodels or the equations in this paragraph (f) to calculate the dynamometer speed setpoint, $f_{\text{nref,dyno}}$, based on the torque measurement location. For all powertrains, configure GEM with the accessory load set to zero. For hybrid engines, configure GEM with the applicable accessory load as specified in 40 CFR 1036.503. For all powertrains and hybrid engines, configure GEM with the tire slip model disabled.

* * * * *

(o) *Create GEM inputs.* Use the results of powertrain testing to determine GEM inputs for the different simulated vehicle configurations as follows:

(1) Correct the measured or calculated fuel masses, $m_{\text{fuel[cycle]}}$, and mean idle

fuel mass flow rates, $\bar{m}_{\text{fuelidle}}$, if applicable, for each test result to a mass-specific net energy content of a reference fuel as described in 40 CFR 1036.535(f), replacing \bar{m}_{fuel} with $m_{\text{fuel[cycle]}}$ where applicable in Eq. 1036.535-4.

(2) Declare fuel masses, $m_{\text{fuel[cycle]}}$, in g/cycle. In addition, declare mean fuel mass flow rate for each applicable idle duty cycle, $\bar{m}_{\text{fuelidle}}$. These declared values may not be lower than any corresponding measured values determined in this section. If you use multiple measurement methods as allowed in 40 CFR 1036.540(d), follow 40 CFR 1036.535(g) regarding the use of direct and indirect fuel measurements and the carbon balance error verification. These declared values, which serve as emission standards, collectively represent the powertrain fuel map for certification.

(3) [Reserved]

(4) For the transient cycle specified in § 1037.510(a)(2)(i), calculate powertrain output speed per unit of vehicle speed,

$$\left[\frac{\bar{f}_{\text{npowertrain}}}{\bar{v}_{\text{powertrain}}} \right]_{\text{[cycle]}}$$

using one of the following methods:

(i) For testing with torque measurement at the axle input shaft:

$$\left[\frac{\bar{f}_{\text{npowertrain}}}{\bar{v}_{\text{powertrain}}} \right]_{\text{[cycle]}} = \frac{k_a}{2 \cdot \pi \cdot r_{\text{[speed]}}}$$

Eq. 1037.550-8

Example:

$$k_a = 4.0 \\ r_B = 0.399 \text{ m}$$

$$k_a = 4.0$$

$$r_B = 0.399 \text{ m}$$

$$\left[\frac{\bar{f}_{\text{npowertrain}}}{\bar{v}_{\text{powertrain}}} \right]_{\text{transienttest4}} = \frac{4.0}{2 \cdot 3.14 \cdot 0.399}$$

$$\left[\frac{\bar{f}_{\text{npowertrain}}}{\bar{v}_{\text{powertrain}}} \right]_{\text{transienttest4}} = 1.596 \text{ r/m}$$

- (ii) For testing with torque measurement at the wheel hubs, use Eq. 1037.550–8 setting k_a equal to 1.
- (iii) For testing with torque measurement at the engine’s crankshaft:

$$\left[\frac{\bar{f}_{\text{powertrain}}}{\bar{v}_{\text{powertrain}}}\right]_{\text{[cycle]}} = \frac{\bar{f}_{\text{engine}}}{\bar{v}_{\text{ref}}}$$

Eq. 1037.550-9

Where:

$$\left[\frac{\bar{f}_{\text{powertrain}}}{\bar{v}_{\text{powertrain}}}\right]_{\text{transienttest4}} = \frac{31.17}{19.06}$$
$$\left[\frac{\bar{f}_{\text{powertrain}}}{\bar{v}_{\text{powertrain}}}\right]_{\text{transienttest4}} = 1.635 \text{ r/m}$$

\bar{f}_{engine} = average engine speed when vehicle speed is at or above 0.100 m/s.
 \bar{v}_{ref} = average simulated vehicle speed at or above 0.100 m/s.

Example:
 \bar{f}_{engine} = 1870 r/min = 31.17 r/s
 \bar{v}_{ref} = 19.06 m/s

- (5) Calculate engine idle speed, by taking the average engine speed measured during the transient cycle test while the vehicle speed is below 0.100 m/s. (Note: Use all the charge-sustaining test intervals when determining engine idle speed for plug-in hybrid engines and powertrains.)
- (6) For the cruise cycles specified in § 1037.510(a)(2)(ii), calculate the

average powertrain output speed, $\bar{f}_{\text{powertrain}}$, and the average powertrain output torque (positive torque only), $\bar{T}_{\text{powertrain}}$, at vehicle speed at or above 0.100 m/s. (Note: Use all the charge-sustaining and charge-depleting test intervals when determining $\bar{f}_{\text{powertrain}}$ and $\bar{T}_{\text{powertrain}}$ for plug-in hybrid engines and powertrains.)

- (7) Calculate positive work, $W_{\text{[cycle]}}$, as the work over the duty cycle at the axle input shaft, wheel hubs, or the engine’s crankshaft, as applicable, when vehicle speed is at or above 0.100 m/s.
- (8) The following tables illustrate the GEM data inputs corresponding to the different vehicle configurations for a given duty cycle:
(i) For the transient cycle:

Table 2 to paragraph (o)(8)(i) of § 1037.550 – Generic example of output matrix for transient cycle vehicle configurations

Parameter	Configuration								
	1	2	3	4	5	6	7	8	9
$m_{\text{fuel[cycle]}}$									
$\left[\frac{\bar{f}_{\text{powertrain}}}{\bar{v}_{\text{powertrain}}}\right]_{\text{[cycle]}}$									
$W_{\text{[cycle]}}$									
\bar{f}_{idle}									

- (ii) For the cruise cycles:

TABLE 3 TO PARAGRAPH (o)(8)(ii) OF § 1037.550—GENERIC EXAMPLE OF OUTPUT MATRIX FOR CRUISE CYCLE VEHICLE CONFIGURATIONS

Parameter	Configuration								
	1	2	3	4	5	6	7	8	9
$m_{\text{fuel[cycle]}} \cdot$ $\bar{f}_{\text{powertrain[cycle]}} \cdot$ $\bar{T}_{\text{powertrain[cycle]}} \cdot$ $W_{\text{[cycle]}} \cdot$									

■ 11. Amend § 1037.810 by revising paragraph (c) to read as follows:

§ 1037.810 Incorporation by reference.
* * * * *

- (c) U.S. EPA, Office of Air and Radiation, 2565 Plymouth Road, Ann Arbor, MI 48105, www.epa.gov.
(1) Greenhouse gas Emissions Model (GEM), Version 2.0.1, September 2012 (“GEM version 2.0.1”), IBR approved for § 1037.520.
- (2) Greenhouse gas Emissions Model (GEM) Phase 2, Version 3.0, July 2016 (“GEM Phase 2, Version 3.0”); IBR approved for § 1037.150(bb).
- (3) Greenhouse gas Emissions Model (GEM) Phase 2, Version 3.5.1, November

2020 (“GEM Phase 2, Version 3.5.1”); IBR approved for § 1037.150(bb).

(4) Greenhouse gas Emissions Model (GEM) Phase 2, Version 4.0, April 2022 (“GEM Phase 2, Version 4.0”); IBR approved for §§ 1037.150(bb); 1037.520; 1037.550(a).

(5) GEM’s MATLAB/Simulink Hardware-in-Loop model, Version 3.8, December 2020 (“GEM HIL model 3.8”); IBR approved for § 1037.150(bb).

Note 1 to paragraph (c): The computer code for these models is available as noted in paragraph (a) of this section. A working version of the software is also available for

download at www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-emissions-model-gem-medium-and-heavy-duty.

* * * * *

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